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How to save the world with Leerdammer cheese: Engineering nanoporous materials for clean water



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1. Introduction: World saving holes



1 in 5 people do not have access to clean water

Declining water quality is a growing problem for all countries, including the United Kingdom.⁽¹⁾ New toxins and chemicals keep entering our water supply, and current water treatment methods can not keep up. Help comes from materials that, much like Leerdammer cheese, are full of holes. These materials are called activated carbons, and they have been used in water filtration since ancient times.



Leerdammer Cheese

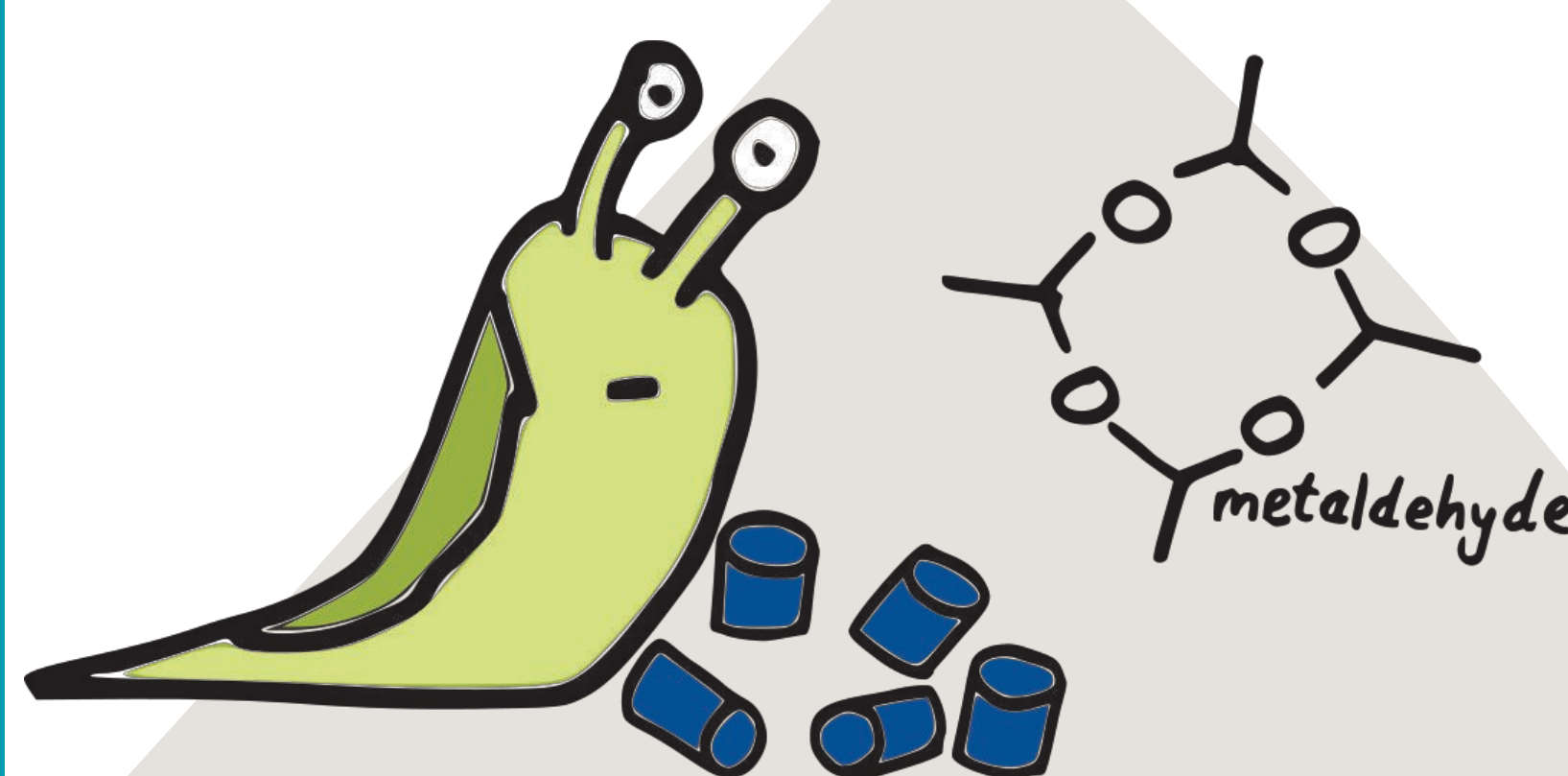


Activated carbon

It is nano-scale sized holes that give activated carbons world-saving potential. A nanometre is one millionth of a millimetre.

2. Targeting toxins

Toxins stick to the surface of our Leerdammer-cheese like carbons, removing them from the water supply. The more holes the material has, the bigger its surface area, and the more toxins it can remove.

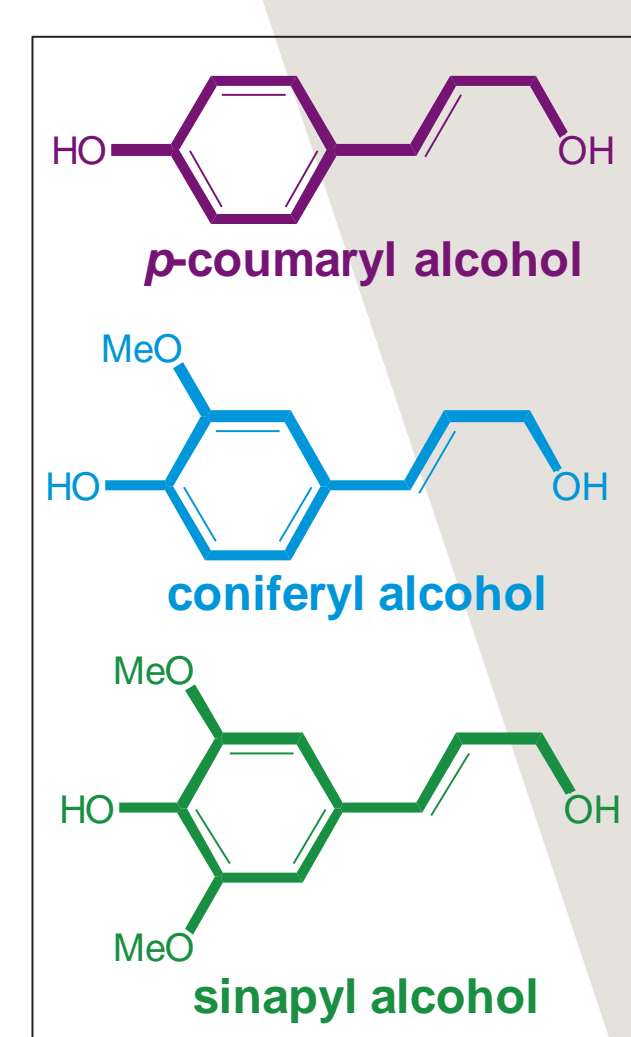


Metaldehyde, commonly used in slug pellets, is a difficult contaminant to remove with standard activated carbons.

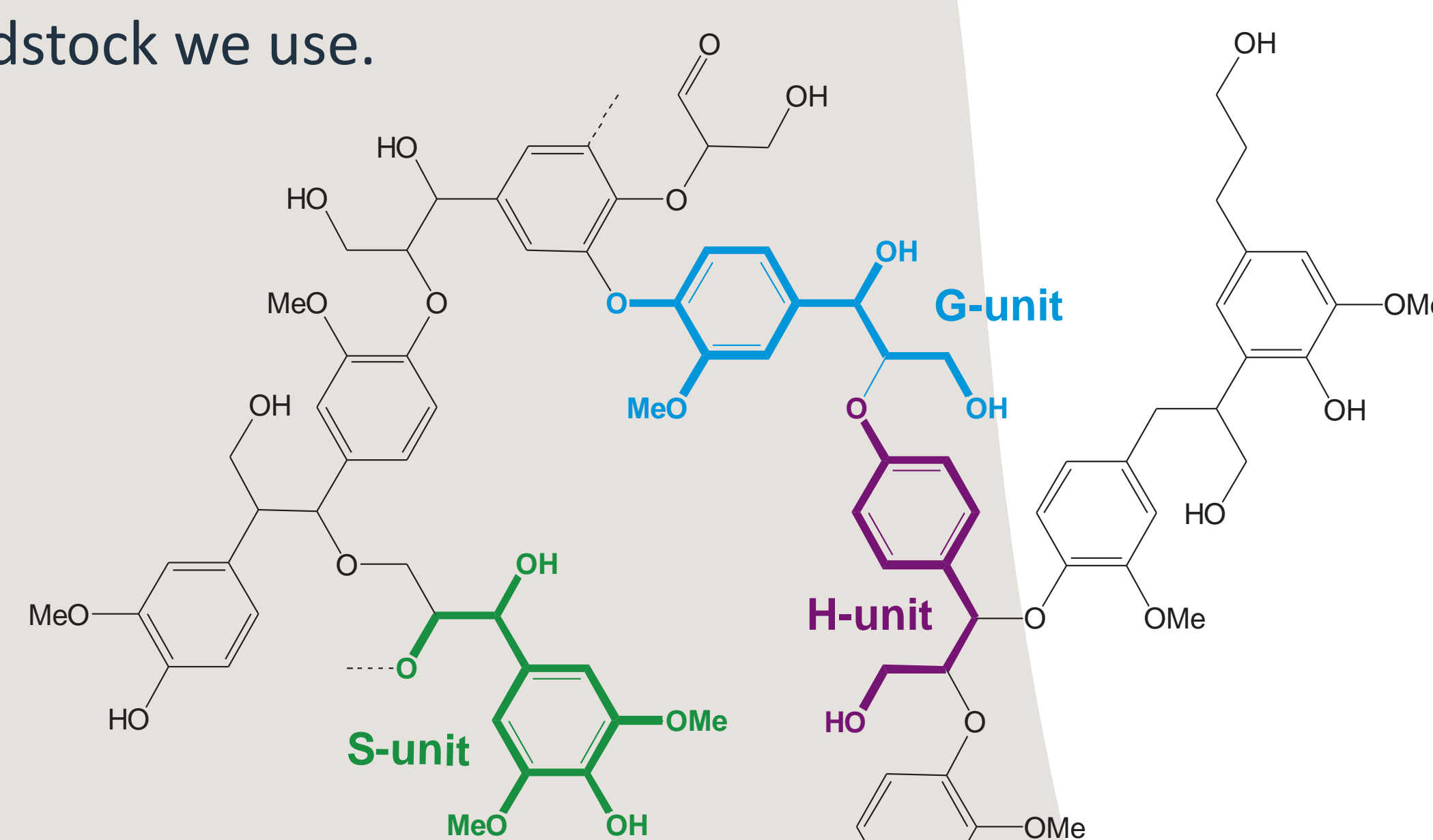
Some toxins however are tricky to remove, such as the pesticide metaldehyde. Our research looks to engineer carbons with specific sized holes to target these tricky toxins and selectively remove them from the water supply.

3. Importance of Structure

The feedstock we make activated carbons from could have a big impact on the size and shape of their holes. We aim to tune the pore size of carbons by changing the feedstock we use.



The three main building blocks of lignin are aromatic rings



The structure of Lignin with the building blocks highlighted. Adapted from Christopher *et al.*⁽²⁾

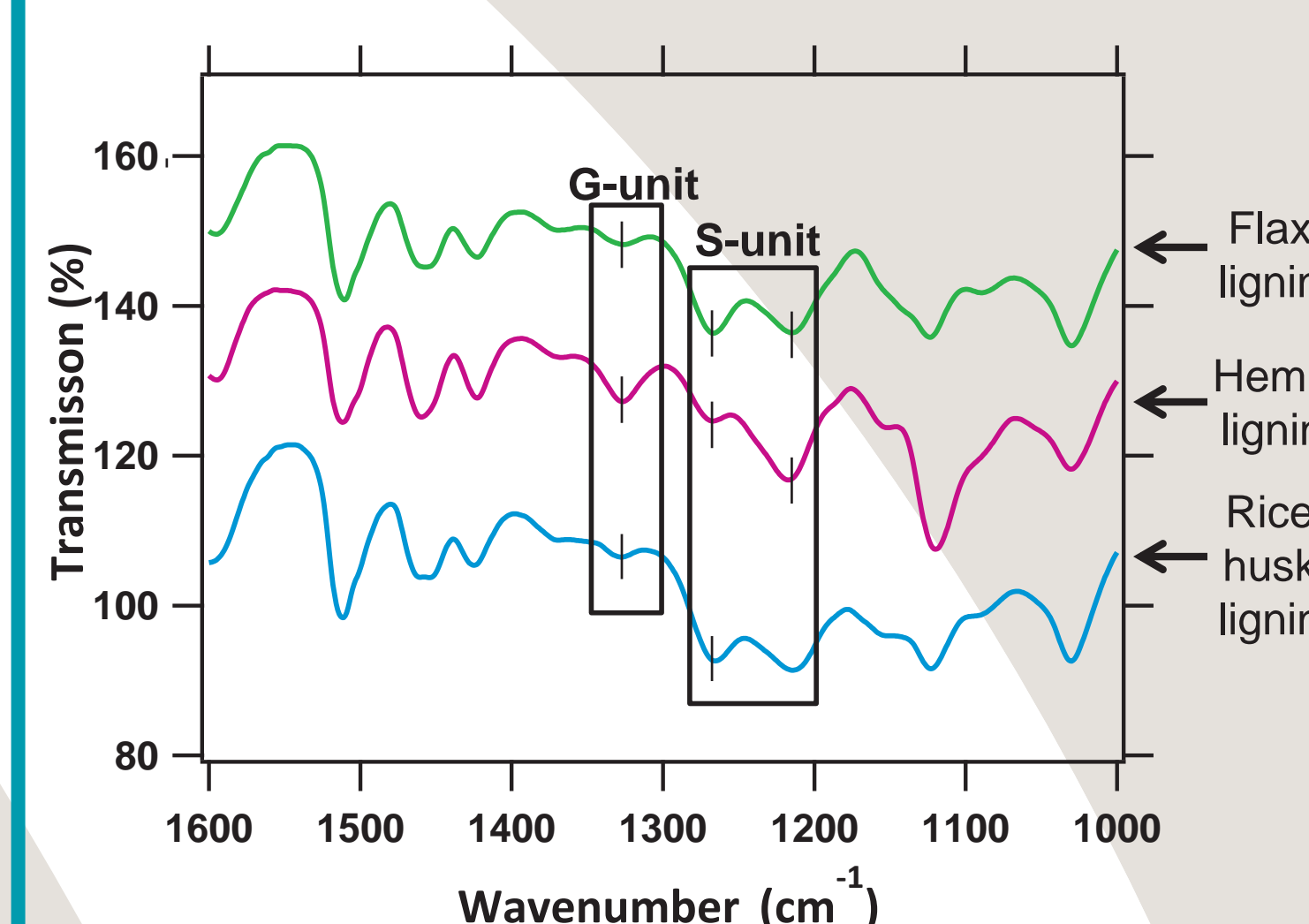
We are investigating using lignin, a polymer found in plants and a major by-product of the paper industry. The polymer is made up of three major building blocks. The number and ratio of these can be wildly different in lignins from different sources.

4. Results

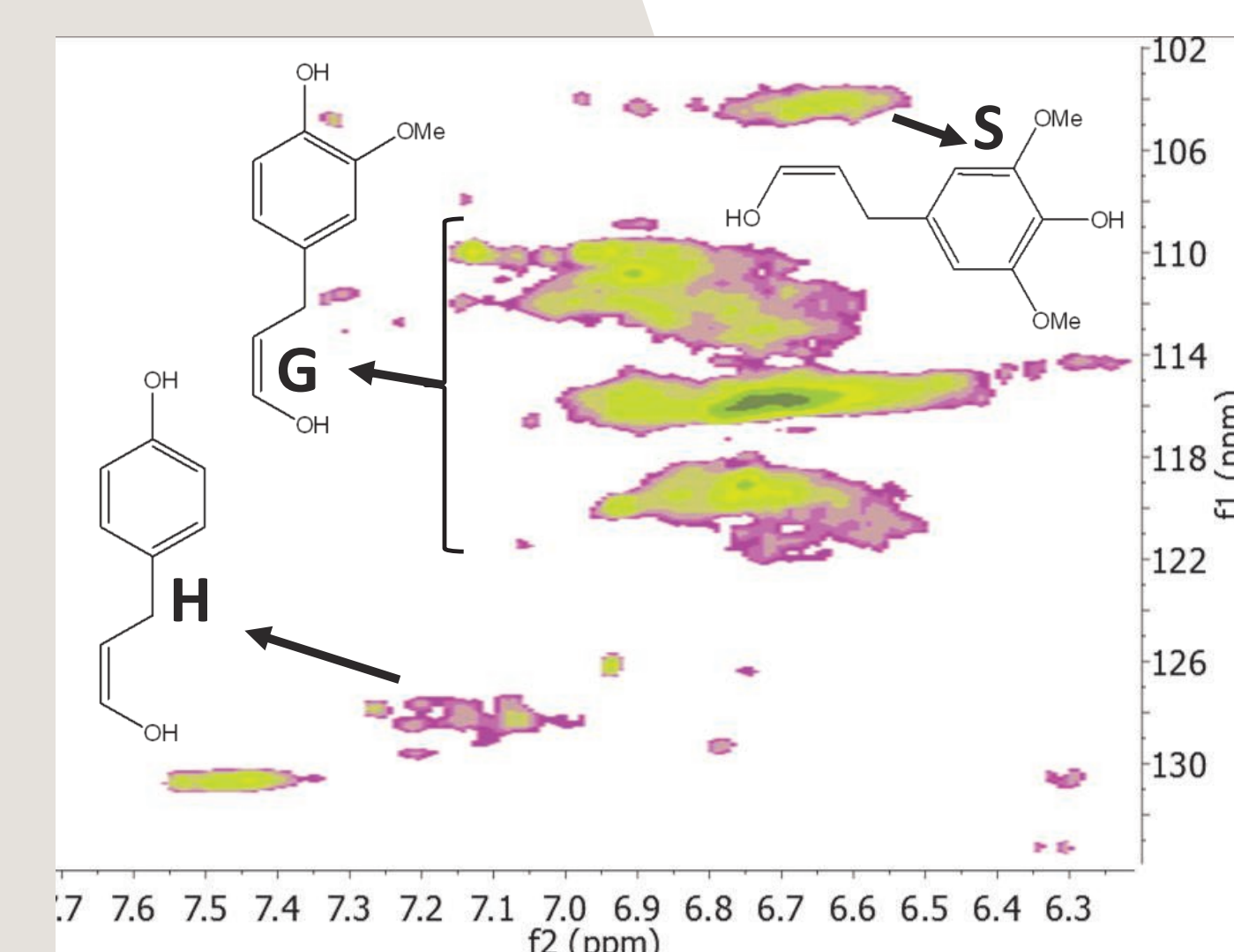
We have investigated the structure of lignins from three different feedstocks (flax, hemp and rice husk). The number and ratio of building blocks was shown to vary between each type of lignin.



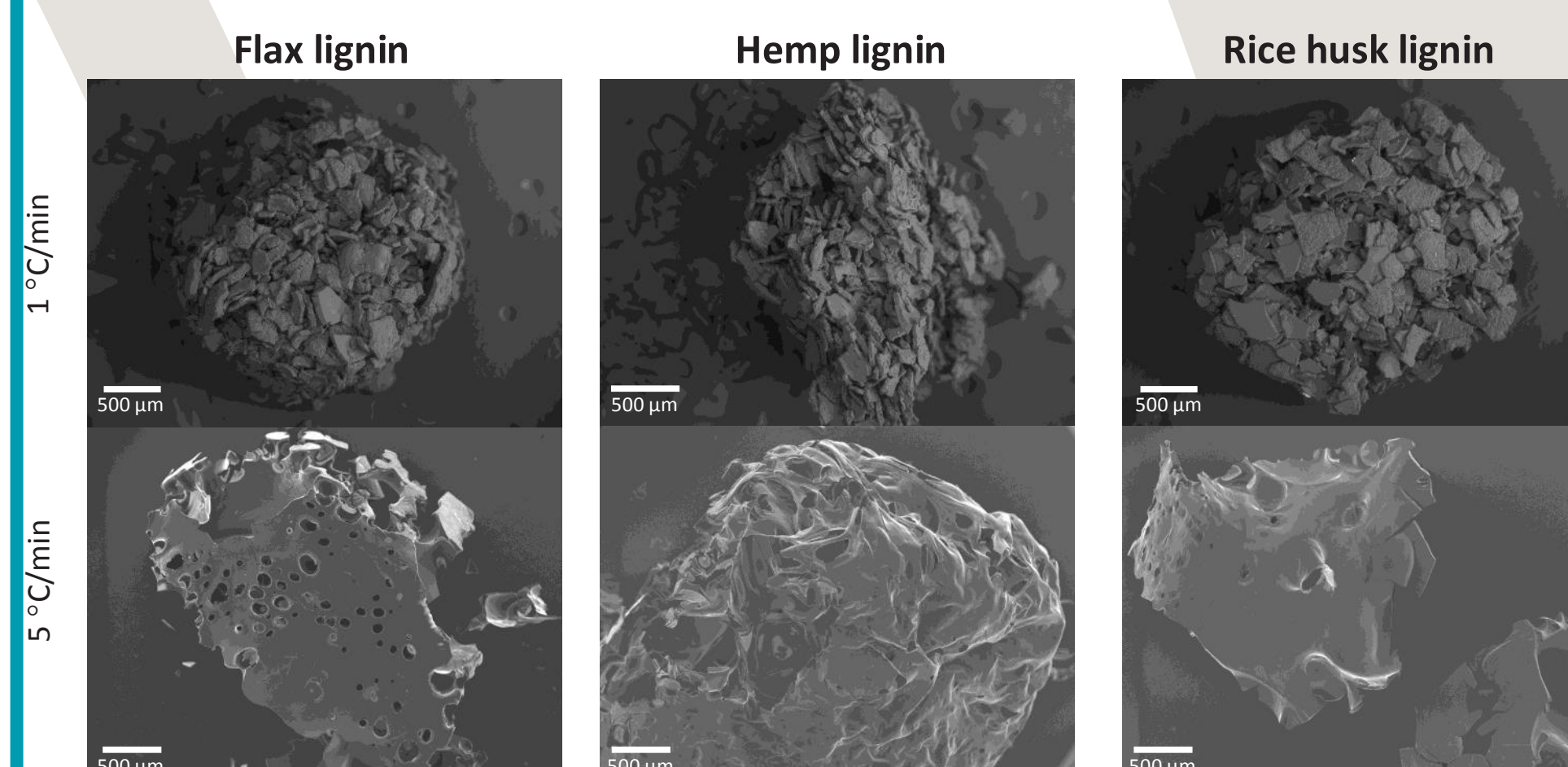
Lignin was extracted from three different feedstocks.



Infrared measurements indicated the ratios of the S and G building blocks varied between different lignins.



Patterns in two-dimensional NMR were used to identify which building blocks were present in our lignins.



Scanning electron microscopy was used to look at the structure of lignins converted into carbon chars at different heating rates.

Initial tests revealed lignins behave differently on conversion to carbons. This is a promising indication the carbon structures prepared from different lignins could vary.

5. Summary

- It has been proven that lignins from different feedstocks vary in structure.
- On conversion to carbons, lignins exhibit dissimilar behaviour.
- This is a promising indication that the structure of the lignins from different feedstocks influences the final carbon structure.

Next Steps

- Our next step is the lab-scale production of activated carbons from lignin, and to examine their structure to see if the size or shape of the holes changes.
- If we can affect the carbon structure we can then try and control the size and shape of holes we produce.
- We will upgrade an existing waste product to activated carbons, and use these Leerdammer-cheese like materials to target specific toxins and remove them from the water supply.

References:

(1) Water UN, 2007 World water day, 2007.

(2) L. P. Christopher, B. Yao, and Y. Ji, *Front. Energy Res.*, 2014, **2**, 12.



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